**Citation:**

Bes-Rastrollo M, Sabaté J, Gómez-Gracia E, Alonso A, Martínez JA, Martínez-González MA. Nut consumption and weight gain in a Mediterranean cohort: The SUN study. *Obesity (Silver Spring)*. 2007;15(1):107-116.

**PubMed ID:** 17228038

**Study Design:**

Prospective Cohort Study

**Class:**

B - Click here for explanation of classification scheme.

**Research Design and Implementation Rating:**

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

**Research Purpose:**

To assess the association between nut consumption and risk of weight gain (at least 5 kg) or the risk of becoming overweight/obese in a Mediterranean cohort of free-living adults.

**Inclusion Criteria:**

- Subjects were university graduates.
- Those completed a baseline assessment before December 31, 2003.
- Those successfully answered the 2-year follow-up questionnaire.
- Informed consent was implied by the voluntary completion of the baseline questionnaire.

**Exclusion Criteria:**

- 1474 subjects did not answer the 2-year follow-up questionnaire. After five mailings, they were considered lost to follow-up.
- 1039 reported extreme (low or high) values for total energy intake (800 kcal/d for men, 500 kcal/d for women or 4000 kcal/d for men, 3500 kcal/d for women).
- Subjects with missing values in variables of interest
- Subjects with biologically implausible values for weight and/or height

**Description of Study Protocol:**

**Recruitment**

- The recruitment of participants started in December 1999 and the study was permanently open, because it was designed to be a dynamic cohort.

- As of December 2005, the dataset included 16,378 participants. All participants who completed a baseline assessment before December 31, 2003 were eligible for these analyses (n=11,714).

**Design:** Prospective cohort study

**Blinding used (if applicable):** Not described

**Intervention used (if applicable):** not applicable

### Statistical Analysis

- Nonconditional logistic regression models were fit to assess the relationship between the frequency of nut consumption and the risk of weight gain (≥5 kg at follow-up), as well as the risk of becoming overweight/obese (BMI≥25kg/$m^2$).
- Odds ratios (ORs) and their 95% CIs were calculated, using never/almost never consumption as the reference category.
- Tests of linear trend across increasing categories of consumption were conducted by assigning medians for the frequency of intake of each category and treating them as a continuous variable.
- Least squares regression models were used to assess the association between frequency of nut consumption and weight change at follow-up.
- Regression coefficients for the three other categories of participants were estimated using never/almost never consumption as the reference category.
- A crude model, an age- and sex-adjusted model, and a multivariate model were fitted after additional adjustment for baseline BMI, leisure time physical activity, smoking status, snacking between meals, and TV watching.
- All first-order multiplicative interactions were evaluated through product terms.
- All p values presented are two-tailed; $p<0.05$ was considered statistically significant, unless otherwise specified.

## Data Collection Summary:

### Timing of Measurements

- Dietary habits were assessed through a baseline semi-quantitative food frequency questionnaire that has been validated in Spain.
- The baseline assessment also included medical history, health habits, lifestyle and sociodemographic variables, and physical activity.
- Participants' weight was self-recorded at baseline and the 2-year follow-up. The mean relative error in self-reported weight was 1.45% and correlation coefficient between measured and self-reported weight was 0.99.

### Dependent Variables

- Weight gain: an increase in weight ≥5 kg during follow-up
- Incident overweight: Participants with a BMI<24.9 kg/$m^2$ at baseline and a BMI≥25kg/$m^2$ at follow-up
- Incident obesity: Participants with a BMI<29.9 kg/$m^2$ at baseline and a BMI≥30kg/$m^2$ at follow-up

### Independent Variables

- Frequency of nut consumption including walnuts, almonds, hazelnuts, and peanuts
- Nutrient intake scores

### Control Variables

- Baseline BMI
- Leisure time physical activity
- Smoking status
- Snacking between meals
- TV watching

## Description of Actual Data Sample:

**Initial N**:11,714 were eligible for the analyses.

**Attrition (final N):** 8,865 were used in the statistical analyses, suggesting dropout rate 24.3%.

**Age**: Mean age by frequency of nut consumption as follows: never/almost never group: 35.6±11.9; 1-3 times/month group: 36.7±11.8; once per week group: 37.6±12.0; at least 2 times/week group: 41.5±13.1

**Ethnicity**: not described

**Other relevant demographics**:There were no significant group differences on age and gender.

**Anthropometrics:** There were no significant group differences on BMI and baseline weight.

**Location**: Navarra, Spain

## Summary of Results:

### Key Findings

- 937 participants reported a weight gain of at least 5 kg at the 28-month follow-up.
- After adjusting for age, sex, smoking, leisure time physical activity, and other known risk factors for obesity, participants who ate nuts 2 or more times per week had a significantly lower risk of weight gain (odds ratio: 0.69; 95% CI: 0.53 to 0.90, p for trend=0.006) than those who never or almost never ate nuts.
- Participants with little nut consumption (never/almost never) gained an average of 424 grams (95% CI: 102 to 746) more than frequent nut eaters.
- Nut consumption was not significantly associated with incident overweight/obesity in the cohort.

## Author Conclusion:

Frequent nut consumption was associated with a reduced risk of weight gain (5 kg or more). These results support the recommendation of nut consumption as an important component of a cardioprotective diet and also allay fears of possible weight gain.

## *Reviewer Comments:*

*Strengths:*

- *Sample size was large enough.*
- *Measurements of food intakes and activity levels were described adequately and were based on standard, valid and reliable instruments.*

- *Adjustments in statistical analysis were made to ensure groups were comparable on important confounding factors.*
- *Study limitations (e.g., a non-representative sample and self-reported weight) were identified and discussed.*
- *The conclusion was supported by results with limitations taken into consideration.*

*Limitations*

- *The participants were not a representative sample of the general population.*
- *Because dropout rate was not very low, the health and other characteristics of withdrawals and participants should be compared to rule out selection bias.*
- *Dietary habits only measured at baseline*
- *It was unclear if blinding was used for data collectors and subjects to prevent introduction of bias.*
- *Body weight was not measured multiple times with a standardized scale to ensure accuracy, based on self-report*

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***Research Design and Implementation Criteria Checklist: Primary Research***

| **Relevance Questions** | | |
|---|---|---|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | N/A |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about? | Yes |
| 3. | Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice? | Yes |
| 4. | Is the intervention or procedure feasible? (NA for some epidemiological studies) | N/A |

| **Validity Questions** | | |
|---|---|---|
| **1.** | **Was the research question clearly stated?** | Yes |
| 1.1. | Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified? | Yes |
| 1.2. | Was (were) the outcome(s) [dependent variable(s)] clearly indicated? | Yes |
| 1.3. | Were the target population and setting specified? | Yes |
| **2.** | **Was the selection of study subjects/patients free from bias?** | No |
| 2.1. | Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study? | Yes |
| 2.2. | Were criteria applied equally to all study groups? | Yes |

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|---|---|---|
| 2.3. | Were health, demographics, and other characteristics of subjects described? | No |
| 2.4. | Were the subjects/patients a representative sample of the relevant population? | No |
| **3.** | **Were study groups comparable?** | Yes |
| 3.1. | Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT) | Yes |
| 3.2. | Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline? | Yes |
| 3.3. | Were concurrent controls used? (Concurrent preferred over historical controls.) | Yes |
| 3.4. | If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis? | Yes |
| 3.5. | If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.) | N/A |
| 3.6. | If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")? | N/A |
| **4.** | **Was method of handling withdrawals described?** | No |
| 4.1. | Were follow-up methods described and the same for all groups? | No |
| 4.2. | Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.) | No |
| 4.3. | Were all enrolled subjects/patients (in the original sample) accounted for? | Yes |
| 4.4. | Were reasons for withdrawals similar across groups? | No |
| 4.5. | If diagnostic test, was decision to perform reference test not dependent on results of test under study? | N/A |
| **5.** | **Was blinding used to prevent introduction of bias?** | No |
| 5.1. | In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate? | N/A |
| 5.2. | Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.) | No |

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| 5.3. | In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded? | No |
| 5.4. | In case control study, was case definition explicit and case ascertainment not influenced by exposure status? | N/A |
| 5.5. | In diagnostic study, were test results blinded to patient history and other test results? | N/A |
| **6.** | **Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?** | Yes |
| 6.1. | In RCT or other intervention trial, were protocols described for all regimens studied? | N/A |
| 6.2. | In observational study, were interventions, study settings, and clinicians/provider described? | Yes |
| 6.3. | Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect? | Yes |
| 6.4. | Was the amount of exposure and, if relevant, subject/patient compliance measured? | N/A |
| 6.5. | Were co-interventions (e.g., ancillary treatments, other therapies) described? | N/A |
| 6.6. | Were extra or unplanned treatments described? | N/A |
| 6.7. | Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups? | N/A |
| 6.8. | In diagnostic study, were details of test administration and replication sufficient? | N/A |
| **7.** | **Were outcomes clearly defined and the measurements valid and reliable?** | ??? |
| 7.1. | Were primary and secondary endpoints described and relevant to the question? | Yes |
| 7.2. | Were nutrition measures appropriate to question and outcomes of concern? | Yes |
| 7.3. | Was the period of follow-up long enough for important outcome(s) to occur? | Yes |
| 7.4. | Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures? | ??? |
| 7.5. | Was the measurement of effect at an appropriate level of precision? | ??? |
| 7.6. | Were other factors accounted for (measured) that could affect outcomes? | Yes |
| 7.7. | Were the measurements conducted consistently across groups? | Yes |
| **8.** | **Was the statistical analysis appropriate for the study design and type of outcome indicators?** | Yes |

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|---|---|---|
| 8.1. | Were statistical analyses adequately described and the results reported appropriately? | Yes |
| 8.2. | Were correct statistical tests used and assumptions of test not violated? | Yes |
| 8.3. | Were statistics reported with levels of significance and/or confidence intervals? | Yes |
| 8.4. | Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)? | N/A |
| 8.5. | Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)? | Yes |
| 8.6. | Was clinical significance as well as statistical significance reported? | Yes |
| 8.7. | If negative findings, was a power calculation reported to address type 2 error? | N/A |
| **9.** | **Are conclusions supported by results with biases and limitations taken into consideration?** | Yes |
| 9.1. | Is there a discussion of findings? | Yes |
| 9.2. | Are biases and study limitations identified and discussed? | Yes |
| **10.** | **Is bias due to study's funding or sponsorship unlikely?** | Yes |
| 10.1. | Were sources of funding and investigators' affiliations described? | Yes |
| 10.2. | Was the study free from apparent conflict of interest? | Yes |